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THE COMPOSITION OF THE OIL-SEEDS OF INDIA

BY

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Imperial Agricultural Chemist

AGRICULTURAL RESEARCH INSTITUTE, PUSA

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THE COMPOSITION OF THE OIL-SEEDS OF INDIA.

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J. WALTER LEATHER, PH.D., F.I.C., F.C.S.,

Imperial Agricultural Chemist, Agricultural Research Institute, Pusa.

In 1901 and again in 1903, details regarding the chemical composition of Indian food-grains and fodders, as determined in this laboratory, were published in the Agricultural Ledger (1901, No. 10, and, 1903, No. 7). These publications contain some information regarding the oil-seeds of India, but the number of specimens which had then been examined was too limited to admit of a definite opinion being formed regarding the variations which occur in the amount of oil in such seeds in different Provinces.

Since then a large number of specimens of oil-seeds received from various Provinces in India have been examined for oil, and their general composition in other particulars has also been determined. The details are set out in this Memoir.

There is indeed much less accurate information about oil-seeds than about the so-called food-grains. It is probable that all the large crushing firms in Europe and America possess a good knowledge of the amount of oil present in the seeds they deal with, but such information is not usually published. Standard books give but little information ; Church's " Food Grains " provides one analysis of one oil-seed, and other authors reproduce odd analyses. American writers are more liberal, but even their exhaustive literature does not, I believe, do justice to the subject. I have referred under the head of the individual seeds to such data as I

have been able to find. A correct knowledge of the amount of oil in these seeds is naturally of value to all parties concerned. To the agriculturist it is of importance to know whether the seed grown by him compares favourably or otherwise with what is grown elsewhere, and one of the chief points brought out by this series of analyses is the variation in the amount of oil which is found in the same seed grown in different Provinces. These differences are not always great, but in some this is the case. To the crusher too, such information must be of not less value, because the amount of oil expressible from any seed varies in a ratio even greater than is indicated by the percentage amount. When an oil-seed is crushed, it may be said that, when using the same mill and a like pressure, the cake will retain approximately the same amount of oil whatever the seed contains. For example, if two samples of an oil-seed, containing respectively 50 % and 40 % of oil, are crushed, and the cake contains 10 % of oil, the nett result is that the one will yield 50 minus $\frac{50 \times 10}{90} = 5{\cdot}5$ or $44{\cdot}5$ parts of oil, while the other will yield 40 minus $\frac{60 \times 10}{90} = 6{\cdot}7$ or $33{\cdot}3$ parts of oil.

Another important subject is touched upon in this Memoir, and about which more precise data will, it is hoped, be obtained in the future. After some of these analyses had been made, specimens of some oil-seeds which had been shown to be richer in oil in one Province than in another, were grown in the latter Province and the seed so obtained analysed. In most cases the result of the experiment indicated that the newly imported seed had suffered deterioration. Unfortunately, however, in all but one such experiment, the initial seed was not analysed, and this fact alone detracts much from the value of the experiments. For it will be obvious that, because certain specimen (say) of sessamum from the Deccan was found to be rich, it does not follow that a precisely equally good sample can be obtained a year or so later ; and if this latter is grown in another part of India and the seed analysed, and found to be less rich than the former sample, no proof is provided that depreciation has followed the transfer to the new Province. In one case, however,

the above indicated precautions were taken. Linseed was obtained from several parts of India and grown at Lyallpur in the Punjab. Some of this seed was analysed, as was also the newly-grown crop, and again in the second year the corresponding checks were made. I am permitted by the Director of Agriculture to refer to this experiment and, as the figures show, there seems to be distinctly less oil in the seed grown at Lyallpur than in the original. It is undesirable to draw general deductions from an isolated experiment, and we must hope that either imported oil-seeds into a Province possessing only poor qualities of the seed in question will become rapidly acclimatized and regain their former richness, or that means may be found of increasing the amount of oil where the evidence indicates poverty in the seed.

The whole of the individual analyses have been incorporated in the text. These details render the pages a mass of statements, but I hope that those who are interested will find them more useful than if merely average figures had been given.

All the specimens could be readily classed under the genus to which they belong. But it was quite unsafe to try to differentiate between varieties, except in the case of some of the Brassicæ from Bengal, which Colonel Prain kindly identified for me in 1900. The specimens of Brassica varieties and of Sessamum included obviously seed of very different size and colour, and it was necessary to group them under corresponding heads. But the other oil-seeds are not so readily divided, and these have, therefore, been merely grouped according to the Province of origin.

Regarding the analytical methods adopted, reference need only be made to that employed for the determination of the oil. When oil-seeds are crushed, they usually assume a very pasty consistence, and it is impossible to ensure the direct disintegration of all the oil-bearing cells. I have, therefore, adopted the plan of first extracting most of the oil from the weighed portion, and then air-drying, re-crushing and re-extracting the residue. After removal of most of the oil, the material is very readily disintegrated in an iron mortar. The procedure is as follows :—The weighed oil-seed, as crushed in a mill (Castor bean was crushed in a mortar), was

extracted with ether in a soxhlet for about two hours ; the paper case was taken out and exposed until the ether had vaporized ; the oil-flask removed, dried, and weighed as usual. The air-dry and partially exhausted material was then pounded in an iron mortar which was itself placed on a large sheet of clean paper, the object of the latter being to secure any material which might be thrown out of the mortar during the disintegration. Although this precaution was naturally necessary, the experience was that very little material was ejected during the operation. After this pulverization, the material was carefully transferred to the paper case again, and extracted for a further period of 1 hour to $1\frac{1}{2}$ hours. The amount of oil obtained by this second extraction was usually considerable, varying from ·020 grm. to ·150 grm. It may seem at first sight a dangerous process to take weighed material and grind it in a mortar in this manner and that the risk of loss must be great. Apart from it being the only method I could adopt for the purpose, the risk of serious error is not really great. The weight of material employed was about 3 grms. and, supposing that so much as $\frac{1}{10}$ part of this were lost through carelessness (no such loss need ever occur), it would mean a loss of oil not greater than ·015 grms., and this is equal to ·5 per cent. as reckoned on the fresh material. Had this second crushing been neglected, the loss, due to unextracted oil, would often have amounted to ·1 grm. or about 3·33 per cent.

The list of seeds which have been examined includes :—

Arachis hypogæa (Earthnut).
Bassia latifolia (Mowha).
Brassica (Sarson, Toria, Rai).
Carthamus tinctorius (Safflower).
Eruca sativa (Taramira).
Gossypium (Cotton seed).
Guizotia abyssynica (Niger).
Linum usitatissimum (Linseed).
Papaver somniferum (Poppy).
Ricinus communis (Castor bean).
Sessamum indicum (Til, jinjilly).

ARACHIS HYPOGÆA—(*Earthnut*).

	Bombay and Madras only.
Area in acres	500,000
Outturn in tons	200,000

Some information regarding this crop was published in Bulletins Nos. 28 and 41 of the Madras Agricultural Department, in the latter of which it was shown that the "Mauritius" variety contained generally 44 to 49 per cent. of oil, whereas the "indigenous" kernels contained only 40 to 44 per cent. Since then a number of other samples have been examined not only from Madras but also from the Bombay Presidency and from Burma, and these are detailed in the subjoined statements. Most of these newer samples have, however, been recently imported, and although of interest as showing the quality of the newer seed, they do not refer to such extensive areas as the "indigenous" or "deshi" samples. Generally speaking, what was observed among the former Madras specimens, holds also for those from the Bombay Presidency, namely, the "indigenous" seed is not so rich in oil as the newly imported. The Burmese specimens are, however, as rich as the latter. The table shows that the "indigenous" seed contains from 40 to 45 per cent., whilst the imported varieties contain from 45 to 50 per cent. ; a difference almost exactly similar to that previously observed in Madras specimens. These figures refer to the proportion of oil in kernels. The amount present in the whole seed, including the shell, has been calculated on the assumption that the shell contains no oil, and these figures are also entered in the statement.

Sample No.	Vernacular name.	District.	Kernels. Per cent.	Shells. Per cent.	Oil in kernels. Per cent.	Oil in whole seed. Per cent.	Weight of 100 kernels. Grms.
		Madras Presidency.					
714—04	Groundnut ...	North Arcot...	74·08	25·92	45·27	33·54	30·4
715—04	Country ...	Do. ...	72·95	27·05	43·19	31·51	26·9
716—04	Groundnut ...	Do. ...	80·04	19·96	45·95	36·78	39·2
717—04	Mauritius ...	Do. ...	77·94	22·06	48·12	37·50	44·5
1042—04	Do. ...	Do. ...	78·18	21·92	48·51	37·93	39·1
1198—04	"London" ...	South Arcot ...	75·40	24·60	49·36	37·22	56·1
811—04	Groundnut ...	Tanjore ...	80·16	19·84	49·16	39·41	38·7
1—06	Small Japanese ...	Palur ...	81·18	18·82	48·34	39·24	...
2—06	Big Japanese	Do. ...	77·22	22·78	48·33	37·32	...

Sample No.	Vernacular name.	District.	Kernels, Per cent.	Shells. Per cent.	Oil in kernels. Per cent.	Oil in whole seed. Per cent.	Weight of 100 kernels. Grms.
		Madras Presidency—(concld.)					
3—06	Tata selected	Palur ...	76·25	23·75	48·56	37·03	...
4—06	Pondicherry	Do. ...	78·71	21·29	48·75	38·37	..
5—06	Virginia ...	Do. ...	75·24	24·76	48·05	36·15	...
6—06	Spanish Peanut ...	Do. ...	78·07	21·93	46·72	36·47	...
7—06	Barbados ...	Do. ...	70·96	29·04	46·14	32·74	...
8—06	Mauritius, Ceylon ...	Do. ...	76·90	23·10	49·32	37·93	...
9—06	Tanjore ...	Do. ..	80·58	19·42	49·37	39·78	..
10—06	Madagascar...	Do. ...	75·40	24·60	48·28	36·40	...
11—06	Local Mauritius ...	Do. ...	79·55	20·45	49·21	39·15	...
12—06	Native ...	Do. ..	73·94	26·06	44·88	33·18	...
13—04	Barbados, Ceylon ...	Do. ...	77·55	22·45	44·90	34·82	...
14—06	Mauritius do.	Do. ...	78·22	21·78	47·78	37·37	...
15—06	Mauritius from Mauritius ...	Do. ...	76·66	23·34	48·65	37·30	...

Average of 1900 samples :—

		Kernels. Per cent.	Shells. Per cent.	Oil in kernels. Per cent.
8	Specimens of "indigenous" seed	74·8	25·2	41·82
10	Do. "Mauritius" seed	76·8	23·2	46·09

Sample No.	Vernacular Name.	District.	Kernels. Per cent.	Shells. Per cent.	Oil in kernels. Per cent.	Oil in whole seed. Per cent.	Weight of 100 kernels. Grms.
		Bombay Presidency.					
68—06	Japan, big ...	Sind ...	...	...	48·70	...	...
69—06	Do. small...	Do. ...	...	...	49·51	...	...
70—06	Java ...	Do. ...	...	...	44·74	...	...
71—06	Mozambique	Do. ...	...	...	49·76	...	..
72—06	Pondicherry	Do. ...	...	...	49·23	...	...
73—06	Senegal ...	Do. ...	...	...	48·46	...	...
74—06	Spanish Peanut ...	Do. ...	...	...	48·08	...	...
75—06	Surti, Deshi (country) ...	Do. ...	...	...	41·62	...	...
76—06	Virginia ...	Do. ...	...	...	47·10	...	...
463—04	Japanese, big	Surat ..	75·9	24·1	45·65	34·74	75·0
464—04	Do. small	Do. ...	80·89	19·11	49·75	40·24	52·0
465—04	Pondicherry	Do. ..	72·48	27·52	43·27	31·37	39·0
466—04	Spanish ...	Do. ...	79·22	20·78	48·87	38·72	46·0
467—04	Virginia ...	Do. .	76·85	23·15	47·33	36·37	68·0
468—04	Deshi, country	Do. ...	72·41	27·59	45·27	32·78	41·0
214—06	Virginia ...	Do. ...	...	...	47·21	...	...
215—06	Pondicherry	Do. ...	...	...	48·31	...	...
216—06	J panese, big	Do. ...	...	...	47·68	..	...
217—06	a Do. small	Do. ...	...	...	50·40	...	..
218—06	Spanish Peanut ...	Do. ...	...	...	51·43	...	...

Sample No.	Vernacular name.	District.	Kernels. Per cent.	Shells. Per cent.	Oil in kernels. Per cent.	Oil in whole seed. Per cent.	Weight of 100 kernels. Grms.
		Bombay Presidency—(concld.)					
219—06	Local ...	Surat .	..	...	47·43	.	..
1177—04	Groundnut ...	Belgaum .	...		41·49	.	27·8
1181—04	Do.	Do.	77·32	22·68	42·96	33·22	30·9
1185—04	Do.	Do.	..	..	42·52	.	31·0
251—04	Do. ...	Poona ...	76·44	23·56	43·32	.	33·6
254—04	Do. ...	Ahmednagar...	. .	.	44·86	...	41·3
262—04	Do. .	Sholapur ..	...	...	40·57	..	24·4
325—04	Do. ...	Satara ...	.	.	45·65	.	38·6
		Burma.					
55—04	Groundnut ...	Meiktila ...	75·19	24·81	46·14	34·69	49·4
655—04	Do. ...	Prome ..	78·45	21·55	50·21	39·39	43·2
747—04	Mayaype .	Minbu ..	72·74	27·26	48·58	35·34	36·7
1271—04	Groundnut ...	Hasmongkham	67·77	32·23	44·26	30·00	33·9
1288—04	Myipi ...	Central Burmah.	74·78	25·22	46·36	34·67	38·3
1294—04	Do. ...	Kengtung ...	65·34	34·66	46·06	30·10	34·5

Average composition (*Kernels only*) :—

	Bombay.	Burma.	Madras.
Moisture	6·83	7·26	6·28
Oil	45·36	47·26	46·34
Albuminoids	26·20	26·09	25·59
Soluble Carbohydrates	16·80	14·72	17·42
Woody fibre	2·09	2·05	1·95
Soluble mineral matter	2·63	2·57	2·37
Sand	·09	·05	·05
	100·00	100·00	100·00
Total Nitrogen	4·33	4·24	4·32
Albuminoid Nitrogen	4·19	4·17	4·09

Average proportion of shells and kernels :—

Kernels, per cent	76·44	72·38	76·14
Shells, per cent	23·56	27·62	23·86

Composition of whole seed calculated on the assumption that the shells are entirely indigestible "woody fibre."

Moisture	5·23	5·26	4·78
Oil	34·61	34·20	35·28
Albuminoids	20·05	18·90	19·50
Soluble Carbohydrates	12·87	10·63	13·25
Woody fibre	25·16	29·11	25·34
Soluble mineral matter	2·01	1·86	1·81
Sand	·07	·04	·04
	100·00	100·00	100·00
Total Nitrogen	3·32	3·07	3·29
Albuminoid Nitrogen	3·20	3·02	3·12

BASSIA LATIFOLIA—*Mowha seed* (*Kernels*).

The number of specimens of this seed which has been examined is too small to admit of any general deductions. The analyses are inserted, however, because of the very limited information on the subject which is available.

Sample No.	Local Name.	District.	Oil. Per cent.
	Central Provinces.		
124—04	.....	Nimar	48·13
181—04	Gulli	Seoni	36·01
	United Provinces.		
1070—04	Mahua	Sultanpur	48·15
1071—04	Do.	Do.	46·95
1072—04	Do.	Do.	47·11
1073—04	Do.	Do.	48·67
1074—04	Do.	Do.	49·04
1075—04	Do.	Do.	46·60
1076—04	Do.	Do.	49·19
1077—04	Do.	Do.	49·19

BRASSICA.

	Area in British India. Acres.	Average yield. Tons.
Grown as single crop	... 3,500,000	850,000
Grown as mixed crop	... 2,500,000	

There are few crops in India which include such a variety of seed as the Brassicæ. The individual crops appear to be largely mixtures, and it would have been an advantage if specimens of the pure varieties could have been examined in addition to the specimens of local production, but no opportunity occurred for this. However, since some of the most representative samples, as obtained from different districts, were similar to one another, it was possible to classify them in a great measure. The specimens fall under the following chief groups: "Yellow sarson" (probably Brassica campestris), twenty-five specimens chiefly from the United Provinces; and red or slaty coloured seed of various shapes and sizes, sixty-two specimens. The latter have been sub-divided according to colour and size into Sarshaf or Toria from the Punjab, a slaty brown or dark red seed weighing

from[1] ·2 to ·4 grm. per 100 seeds, and "Sarson kali" from the United Provinces similar in size to "Sarshaf," but redder coloured; and secondly, the "Rai" of the Punjab, a much smaller seed than the foregoing, weighing from ·07 to ·15 grm. per 100 seeds. The other samples have been brought into this classification as far as possible, though characterized by difference in shape, colour and weight.

Yellow Sarson —The fifteen specimens from the United Provinces were uniform in colour and comparatively so in other respects. Their weight varied from ·41 to ·71 grm. per 100 seeds, and if one or two extremes are excluded, the variation is from about ·48 to ·68 grm. It is the heaviest of the varieties of Brassica. The amount of oil varied from 44 to 49 per cent. The Assam specimens were distinctly smaller, weighed ·3 to ·4 grm. per 100, and contained apparently less oil. The specimens from other Provinces were too few in number to admit of general deductions, but they do not appear to contain so much oil as the United Provinces specimens.

"*Sarshaf*" and "*Toria*" from the Punjab are seeds which are characterized by some irregularity in colour and shape. Whether the crop throughout the Province is a mixture, or whether these characteristics are common to the variety, is uncertain. Otherwise the seed is fairly uniform. The weight varies from ·21 to ·41, or excluding extremes ·25 to ·35. It contains generally from 37 to 45 per cent. of oil, *i.e.*, very appreciably less than the yellow seed. Specimens of "Kali Sarson" from the United Provinces were somewhat larger, and distinctly redder in colour. These twelve specimens weighed from ·3 to ·5 and contained from 39 to 46 per cent. of oil, *i.e.*, much about the same as Punjab Sarshaf. From Partabgarh, however, two specimens of a much larger seed were received; they weighed ·66 grm. and contained 46 per cent. of oil. The remaining twenty-five specimens which I have classed under this group varied much more in weight, colour and percentage of oil; some of them

[1] In order to abbreviate this expression of the weight of seeds the mere figures are frequently used in the text by themselves, such as "weight of seeds ·2 to ·4" would mean ·2 to ·4 grm. per 100 seeds.

contained only 33 per cent. oil. The "Toria" from Sind was similar in appearance to that of the Punjab.

Thirdly, the samples of the Punjab "Rai," with two of "Desi-rai" from the United Provinces, have been classed together, because they are distinctly smaller than the foregoing, red in colour and contained less oil; their weight varied from ·07 to ·15, and the percentage of oil varied from 27 to 37.

Among the few references by foreign writers to the amount of oil in Brassica, Armsby mentions 55 per cent. as the highest, 36 per cent. as the lowest and 42·5 per cent. as the mean of a number of specimens.

YELLOW SARSON.

Sample No.	Local Name.	District.	Oil. Per cent.	Weight of 100 seeds. Grms.
		United Provinces.		
664—04	Sarson—Zard	Cawnpore	48·64	·483
665—04	Do.	Do.	47·91	·495
935—04	Do.	Do.	45·47	·603
943—04	Do.	Do.	45·73	·603
939—04	Do.	Unao	48·52	·504
945—04	Do.	Do.	48·16	·522
937—04	Do.	Partabgarh	49·23	·413
940—04	Do.	Do.	48·75	·604
941—04	Do.	Do.	46·33	·640
944—04	Do.	Do.	48·92	·404
936—04	Do.	Do.	46·04	·632
942—04	Do.	Do.	43·84	·640
946—04	Do.	Do	44·60	·630
923—04	Do.	Meerut	45·67	·673
938—04	Do.	Do.	45·41	·710
		Assam.		
405—04	"White" Mustard	Sylhet	45·10	·368
703—04	"Yellow" Mustard	Kamrup	42·61	·315
704—04	Do.	Do.	36·88	·338
238—04	Obhota Sariah	Jorhat	43·68	·399
237—04	Baga do.	Do.	42·68	·326
		Bombay Presidency.		
401—04	Rape	Nadiad	35·72	·439
454—04	Sarson	Surat	43·00	·531
		Central Provinces.		
158—04	Sarson	Raipur	46·75	·466
918—04	Rapeseed—"Yellow"	Bilaspur	47·21	·296
		Punjab.		
86—04	Sarshaf	Kangra	43·88	·489

SARSON—(*other sorts*).

Sample No.	Local Name.	District.	Oil. Per cent.	Weight of 100 seeds. Grms.	
		Punjab.			
89—04	Sarshaf	Muzaffargarh	45·49	·293	Slaty brown and dark red seed.
19—04	Toria	Chenab Canal	44·94	·327	
85—06	Sarshaf	Kangra	44·33	·250	
96—04	Do.	Ambala	42·45	·297	
14—04	Do	Gurgaon	41·95	·415	
68—04	Toria	Montgomery	41·37	·268	
20—04	Sarshaf	Chenab Canal	40·66	·339	
143—04	Toria	Gujrat	40·33	·288	
138—04	Sarshaf	Sialkot	40·04	·212	
137—04	Toria	Do.	39·46	·236	
144—04	Sarshaf	Gujrat	39·45	·349	
152—04	Do.	Rawalpindi	38·53	·273	
95—04	Toria	Ambala	37·96	·292	
9—04	Sarshaf	Hissar	37·88	·344	
88—04	Toria	Muzaffargarh	36·89	·287	
		United Provinces.			
666—04	Sarson—Kali	Cawnpore	39·86	·271	Seed similar in size to Punjab Sarshaf, but redder in colour.
667—04	Do.	Do.	39·03	·309	
950—04	Do.	Do.	39·05	·349	
951—04	Do.	Do.	39·35	·314	
924—04	Do.	Unao	40·64	·366	
949—04	Do.	Do.	40·44	·383	
948—04	Do.	Aligarh	46·73	·478	
952—04	Do.	Do.	46·37	·528	
947—04	Do.	Meerut	40·70	·398	
953—04	Do.	Do.	40·34	·413	
954—04	Do.	Aligarh	41·07	·359	
957—04	Do.	Do.	40·94	·362	
955—04	Sarson—Red	Partabgarh	46·16	·665	
956—04	Do.	Do.	45·53	·660	
958—04	Rai—Siah	Do.	41·80	·368	
959—04	Do.	Do.	41·32	·315	
		Central Provinces.			
197—04	Mustard	Balaghat	46·09	·292	Large, dark red, round seed.
105—04	Sarson	Jabalpur	45·61	·304	
159—04	Rai	Raipur	44·24	·295	
170—04	Mustard	Sambalpur	43·43	·340	
106—04	Rai	Jabalpur	42·16	·213	Irregularly shaped dark red seed.
292—04	Do.	Mandla	40·16	·231	
116—04	Mustard	Hoshangabad	36·34	·276	
133—04	Do.	Damoh	36·16	·229	
219—04	Do.	Chanda	34·36	·241	
220—04	Do.	Do.	32·45	·208	
209—04	Do.	Narsingpur	38·22	·156	Dark red small round seed.
126—04	Do.	Nimar	34·96	·153	
77—04	Rai	Seoni	33·08	·142	
132—04	Jagni or Sarson	Damoh	40·57	·272	
917—04	Rapeseed—"Red"	Bilaspur	45·62	·313	
		Assam.			
239—04	Ranga Sariah	Jorhat	41·11	·327	
240—04	Kala do.	Do.	35·93	·364	
407—04	Mustard	Sylhet	41·50	·286	
705—04	Black Mustard	Kamrup	35·65	·280	
		Bombay Presidency.			
901—04	Toria	Jamrao Canal, Sind	39·23	·298	
902—04	Do.	Do. do.	41·55	·345	

SARSON—(*other sorts*)—contd.

Sample No.	Local Name.	District.	Oil. Per cent.	Weight of 100 seeds. Grms.	
		Bengal.			
475—04	Mustard ...	...	46·60	·300	
		Burmah.			
565—04	Monyin	Prome ...	45·59	·314	
		RAI.			
		Punjab.			
156—04	Rai	Rawalpindi	37·48	·152	Colour similar to Sarshaf, but seed smaller.
147—04	Do.	Gujrat	36·78	·122	
92—04	Do.	Muzaffargarh	35·82	·156	
99—04	Do.	Ambala	31·27	·158	
84—04	Do.	Kangra	35·28	·090	
17—04	Do. ...	Gurgaon	34·13	·113	
12—04	Do. ..	Hissar	29·79	·090	
23—04	Do.	Chenab Canal	29·73	·084	
71—04	Do.	Montgomery	28·61	·077	
141—04	Do.	Sialkot	27·21	·081	
		United Provinces.			
925—04	Desi-Rai ...	Aligarh ...	36·05	·176	
960—04	Do. ...	Do. ...	35·62	·168	

Bengal.

(Published in Agricultural Ledger, 1903, No. 7, pp. 160-1.)

BRASSICA JUNCEA, H. f. & T.

Syn.: Sinapis juncea. Sinapis ramosa, Roxb.

English: Indian Mustard.

Vern.: Asl-rai.

Sample No.	Local Name.	District.	Oil. Per cent.
380—00	"Kajli Sarsa"	24-Parganas ...	40·22
385—00	Lalki tori .	Dumraon	39·46
518—00	Rai	Nadia	32·51
520—00	Do. .. .	Arraria	40·84

BRASSICA NAPUS, Linn.; var. Dichotoma.

English: Indian Rape.

Vern.: Tori, Lutni, Moghi.

388—00	Latni	Hazaribagh	38·21
496—00	Lotni	Ranchi	40·00
519—00	Jehanabad	Bengal	40·18

BRASSICA CAMPESTRIS, Linn.; var. Sarson, Prain.

English: Indian Colza.

Vern.: Sarson, Sweti.

383—00	Piarka tori	Dumraon	41·51
384—00	Lalka tora	Do.	39·73
386—00	Piarki tori	Do.	41·42
389—00	Seta Sarisa	Rangpur	42·62
521—00	... ...	Arrah	43·92

The following illustrates the average composition of the seed :—

	Sarshaf or Toria, *Punjab.*	Rai, *Punjab.*	Rai, *Central Provinces.*	Yellow Sarson, *Central Provinces.*	Yellow Sarson, *United Provinces.*	Yellow Sarson, *Assam.*	Sarson, other sorts, *United Provinces.*
Moisture ...	6·98	7·06	6·04	5·46	6·12	7·01	5·96
Oil ...	39·76	30·28	38·63	45·54	47·42	41·59	40·45
Albuminoids .	17·26	19·88	18·99	15·96	17·29	18·54	18·10
Soluble Carbohydrates	25·63	30·69	27·64	24·06	21·88	23·51	26·55
Woody fibre	5·37	5·92	4·90	4·39	3·59	3·84	4·74
Soluble mineral matter...	4·11	4·99	3·01	3·75	3·50	4·21	3·86
Sand ...	·89	1·18	·79	1·04	·19	1·30	·34
	100·00	100·00	100·00	100·00	100·00	100·00	100·00
Total Nitrogen ...	3·25	3·74	3·74	3·54	2·97	3·23	3·39
Albuminoid Nitrogen ...	2·76	3·18	3·04	2·55	2·77	2·97	2·89

(Published in Agricultural Ledger, 1903, No. 7, pp. 160-1.)

Bengal.

	Brassica juncea. 4 samples, average.	Brassica napus. 3 samples, average.	Brassica campestris. 5 samples, average.
Moisture	7·68	6·69	7·21
Oil	38·26	39·46	41·82
Albuminoids	19·14	18·29	20·09
Soluble Carbohydrates... ..	24·10	23·18	22·04
Woody fibre	5·48	5·24	4·47
Soluble mineral matter	4·29	4·49	3·96
Sand and Silica	1·06	2·84	·39
	100·00	100·00	100·00
Total Nitrogen	3·31	3·17	3·47
Albuminoid Nitrogen	3·06	2·93	3·21

CARTHAMUS TINCTORIUS—(*Safflower seed*).

The accompanying statement exhibits the proportion of oil in thirty samples of *Safflower* seed.

The variation in the amount of oil is not great. The one sample from Bengal contains only 22·47 per cent., but it seemed to be discoloured somewhat; and one sample from Bellary and one from Chhindwara contained less than 24 per cent. But the remainder contained from 26 up to about 32 per cent The Central Provinces samples contained a little earth, but all the others were clean. Any such earth was of course excluded from the portions analysed.

Sample No.	District.	Oil. Per cent.	Weight of 100 seeds. Grms.
	Central Provinces.		
79—04	Seoni	30·49	6·774
163—04	Raipur	26·57	3·405
403—04	Balaghat	26·42	5·264
578—04	Chhindwara	23·54	5·953
707—04	Betul	31·82	6·311
914—04	Bilaspur	29·93	4·379
	Bombay Presidency.		
241—04	Nasik	31·23	4·963
248—04	Poona	30·03	4·910
252—04	Ahmednagar	31·02	4·440
261—04	Sholapur	29·56	4·931
272—04	Dharwar	30·16	4·986
324—04	Satara	32·23	5·218
400—04	Nadiad	28·79	4·210
455—04	Surat	29·51	5·516
471—06	Poona	31·27	5·028
	Madras Presidency.		
404—04	Anantapur	31·05	3·890
500—04	Gooty	33·55	4·153
567—04	Nandyal	30·63	3·885
814—04	Kurnool	29·96	4·622
815—04	Kurnool	30·64	4·540
1034—04	Gooty	28·69	3·916
1047—04	Bellary	26·60	2·973
1052—04	Do.	23·88	4·559
	United Provinces.		
672—04	Cawnpore	28·11	3·348
673—04	Do.	29·00	3·670
927—04	Do.	27·94	4·600
968—04	Partabgarh	29·49	4·204
969—04	Cawnpore	28·40	4·936
970—04	Partabgarh	29·78	4·269
	Bengal.		
477—04	.....	22·47	3·209

AVERAGE COMPOSITION.

	Central Provinces.	Bombay Presidency.	Madras Presidency.	United Provinces.
Moisture	5·31	5·22	6·22	6·16
Oil	27·13	29·85	29·83	27·45
Albuminoids	9·38	12·06	12·66	11·50
Soluble Carbohydrates	27·36	24·91	23·75	25·14
Woody fibre	27·43	25·94	24·46	27·42
Soluble mineral matter	2·48	1·97	2·48	2·23
Sand	·91	·05	·60	·10
	100·00	100·00	100·00	100·00
Total Nitrogen	1·64	2·37	2·16	2·07
Albuminoid Nitrogen	1·56	1·93	2·07	1·84

ERUCA SATIVA.—(*Vern.* : *Taramira.*)

Some specimens of this were received from the Punjab and the United Provinces, together with one sample from Bengal. As will be seen from an inspection of the figures, the specimens from the United Provinces contain appreciably more oil than those from the Punjab, and since this difference is regular, it may be presumed to be a general one. One cannot of course make deductions from the one Bengal specimen. The samples were fairly free from earthy materials.

Sample No.	Local Name.	District.	Oil. Per cent.	Weight of 100 seeds. Grms.
		Punjab.		
11—04	Taramira	Hissar	31·96	·274
16—04	Ditto	Gurgaon	34·77	·321
22—04	Ditto	Chenab Canal	25·40	·248
70—04	Ditto	Montgomery	27·33	·227
91—04	Ditto	Muzaffergarh	30·06	·285
98—04	Ditto	Ambala	32·82	·408
140—04	Ditto	Sialkot	28·12	·206
146—04	Ditto	Gujrat	32·57	·326
154—04	Ditto	Rawalpindi	30·24	·169
		Bengal.		
588—04	Taramira	.....	33·05	·264
		United Provinces.		
926—04	Duan or Taramira ...	Partabgarh	31·72	·345
961—04	Ditto ...	Cawnpore	36·32	·393
962—04	Ditto ..	Partabgarh	31·30	·336
963—04	Ditto ..	Aligarh	36·71	·434
668—04	Ditto ...	Cawnpore	33·65	·258
669—04	Ditto ...	Do.	31·39	·251
964—04	Ditto ...	Meerut	33·69	·448
965—04	Ditto ...	Do.	34·40	·507
966—04	Ditto ...	Aligarh	36·57	·411
967—04	Ditto ...	Cawnpore . .	36·16	·442

AVERAGE COMPOSITION.

	Punjab.	United Provinces.
Moisture	6·81	6·69
Oil	28·99	33·33
Albuminoids	22·82	21·56
Soluble Carbohydrates	29·51	28·63
Woody fibre	5·41	5·19
Soluble mineral matter	4·62	3·92
Sand	1·84	·68
	100·00	100·00
Total Nitrogen	4·21	4·19
Albuminoid Nitrogen	3·65	3·45

GOSSYPIUM—(*Cotton-seed*).

Average area in acres	20,000,000
Approximate outturn in tons	1,200,000

Detailed information regarding the amount of oil in Indian cotton-seed was published in Agricultural Ledger No. 9 of 1903, and a summary only is inserted here.

		Oil in whole seed. Per cent.
26 specimens from	Madras Presidency	17·41
18 ,,	Bombay ,, ...	17·66
15 ,,	Central Provinces	19·65
15 ,,	United ,, ...	19·89

The variation in individual samples was only small, being from 15 to 21 in extreme cases. The amount of oil contained in Indian seed is then very much less than in American, which contains upwards of 30 per cent. The Indian seed is also smaller. Specimens of American weighed 12 to 18 grammes per 100 seeds, and Egyptian 10 to 11 grammes, whilst Indian seed weighed only 5 to 7 grammes.

GUIZOTIA ABYSSYNICA—(*Niger*).

The specimens of this seed were characterized by very considerable uniformity in colour, size of seed and amount of oil.

Sample No.	Local Name.	District.	Oil. Per cent.	Weight of 100 seeds. Grms.
		Central Provinces.		
62—04	Ramtilli	Sagor	38·85	·303
78—04	Jagni ..	Seoni	39·06	·288
104—04	Ramtilli	Jabalpur ..	38·78	·268
122—04	Do.	Nimar	41·71	·298
131—04	Do. or Jagni ...	Damoh	39·03	·341
200—04	Do. or Sarsoa ...	Balaghat	37·30	·204
207—04	Jagni or Ramtilla ...	Narsingpur .	36·17	·244
294—04	Do. ...	Mandla . . .	36·75	·274
575—04	Jagni	Chhindwara . .	36·94	·269
710—04	Do. ..	Betul	38·57	·215
919—04	Ramtilla .	Bilaspur ...	39·96	·360
		Bombay Presidency.		
244—04	Niger	Nasik	39·90	·334
250—04	Do. .	Poona	38·28	·373
255—04	Do. ...	Ahmednagar ...	41·40	·328
260—04	Do.	Sholapur ..	42·00	·409
263—04	Do.	Kolaba	39·29	·325
270—04	Do.	Dharwar ...	40·83	·418
327—04	Do. .	Satara	40·56	·350
413—04	Do. ...	Thana	41·77	·410
456—04	Kharsani .	Surat ..	39·29	·417
473—04	Niger	Poona	43·27	·416

Sample No.	Local Name.	District.	Oil. Per cent.	Weight of 100 seeds. Grms.
		Madras Presidency.		
448—04	Niger	Salem	41·47	·422
533—04	Do.	Berhampur	37·88	·337
740—04	Valesellu	Ganjam	37·47	·311
810—04	Niger	Do.	40·40	·366
1036—04	Do.	Salem	39·45	·394
1046—04	Gronuvulu ...	Bellary	41·87	·464
1051—04	Do.	Do.	41·89	·463
1063—04	Niger	Hasur, Salem	36·37	·370
1062—04	Do.	Do. Do.	36·29	·348
		Bengal.		
494—04	Niger	... ...	40·33	·378

AVERAGE COMPOSITION.

	Central Provinces.	Bombay Presidency.	Madras Presidency.
Moisture	5·53	5·33	6·03
Oil	38·53	39·95	39·10
Albuminoids	18·54	19·02	17·94
Soluble Carbohydrates	19·08	17·99	19·32
Woody fibre	12·31	12·54	11·94
Soluble mineral matter	5·29	4·64	5·18
Sand	·72	·53	·49
	100·00	100·00	100·00
Total Nitrogen	3·07	3·26	3·02
Albuminoid Nitrogen	2·97	3·04	2·87

LINUM USITATISSIMUM—(*Linseed*).

	Area in British India. Acres.	Yield. Tons.
Grown as single crop	3,000,000	300,000
Grown as mixed crop	500,000	

The accompanying statement exhibits the percentage of oil in fifty-four samples of *Linseed* which have been received from the several Provinces named. There is, on the whole, remarkably little variation in the proportion of oil. The Central Provinces and the United Provinces samples contain up to 44 per cent., and some of the Punjab samples fall as low as 37 per cent. (one as low as 35·6) but these are the extremes

Most of them were brown linseed. One sample from Nimar and one from Cawnpore were practically wholly white ; and samples from Surat, Wardha, Hoshangabad, Narsingpur and Sambalpur contained more or less white linseed. All these contained high

proportions of oil, but at the same time equally high proportions were contained by pure brown linseed, so that there is no evidence to show that the one contains generally more oil than the other.

Some of the seed was distinctly small, such as that from Kangra and Rawalpindi, but there is not much evidence that any connection exists between the size of the seed and the amount of oil. Some of the larger Central Provinces varieties weighing ·8 or ·9 gramme per 100 seeds contain only as much oil as No. 920—04 from Bilaspur which weighed only ·55 gramme. At the same time it may be said that all the samples of bold seeds, weighing ·7 gramme or more per 100, contain high percentages of oil.

The only samples which were not clean were those from the Punjab. These, excepting that from the Kangra district, were mixtures of large and small linseed together with rape, wheat, etc., and straw, and they compared very badly with the general purity of the samples from other parts of India.

Sample No.	District.	Colour.	Oil. Per cent.	Weight of 100 seeds. Grms.
		Punjab.		
10—04	Hissar	Brown	40·40	·452
15—04	Gurgaon	Do.	41·50	·560
21—04	Chenab Canal	Do.	41·91	·609
69—04	Montgomery	Do.	37·91	·459
83—04	Kangra	Do.	38·61	·286
90—04	Muzaffargarh	Do.	35·60	·581
97—04	Ambala	Do.	37·59	·553
139—04	Sialkot	Do.	38·02	·614
145—04	Gujrat	Do.	39·41	·630
153—04	Rawalpindi	Do.	37·14	·395
		Central Provinces.		
63—04	Saugor	Brown	42·43	·967
76—04	Seoni	Do.	43·35	·710
103—04	Jabalpur	Do.	42·93	·721
115—04	Hoshangabad	¼ White	40·64	1·029
123—04	Nimar	White	43·64	·757
128—04	Damoh	Brown	44·20	·890
160—04	Raipur	Do.	39·89	·520
176—04	Sambalpur	¼ White	42·09	·724
194—04	Balaghat	Brown	42·90	·544
206—04	Narsingpur	½ White	42·77	·854
221—04	Chanda	Brown	40·74	·815
222—04	Do.	Do.	41·88	·752
223—04	Do.	Do.	43·15	·788
293—04	Mandla	Do.	40·17	·523
542—04	Hoshangabad	"Khakhri" ½ white	43·93	·934
543—04	Do.	"Lal," brown	42·81	·861
848—04	Wardha	White	43·80	·800
549—04	Do.	"Red," brown	36·47	·818

Sample No.	District.	Colour.	Oil. Per cent.	Weight of 100 seeds. Grms.
		Central Provinces—(concld.)		
572—04	Chhindwara	"Red," brown	43·02	·831
711—04	Betul	Brown	41·73	·773
920—04	Bilaspur	,,	42·05	·552
		Bombay Presidency.		
245—04	Nasik	Brown	43·63	·872
246—04	Poona	,,	42·05	·774
258—04	Sholapur	,,	44·45	·835
271—04	Dharwar	,,	41·23	·669
323—04	Satara	,,	42·85	·731
453—04	Surat, ½ white	,,	43·40	·888
472—04	Poona,	,,	41·75	·746
		Madras Presidency.		
568—04	Karnool	Brown	41·49	·696
812—04	Ditto	,,	41·35	·687
813—04	Ditto	,,	41·71	·703
1048—04	Bellary	,,	40·46	·660
1053—04	Do.	,,	40·72	·682
		United Provinces.		
674—04	Cawnpore	Brown	42·87	·558
675—04	Ditto	"Red," brown	42·19	·537
928—04	Partabgarh	White	44·19	·613
929—04	Cawnpore	"Red," brown	44·55	·923
971—04	Partabgarh	,,	42·30	·619
972—04	Cawnpore	,,	42·28	·828
973—04	Ditto	,,	41·70	·803
974—04	Unao	,,	41·44	·775
975—04	Do.	,,	41·77	·743
		Bengal.		
497—04		Brown	41·40	·516
		Assam.		
406—04	Sylhet	Brown	42·06	·521

Among other authorities, Armsby[1] quotes 21·7% of oil as a minimum for flax seed and 35·6% as a maximum. Smetham[2] quotes the following :—

	Oil. Per cent.
Bombay Linseed	38·21
Morschanski	30·81
Black Sea	30·78
Riga	31·19
St. Petersburg	35·31
Alexandria	35·73

The Indian specimens that I have examined are thus richer on the whole than the produce of other countries.

[1] Manual of Cattle Feeding, p. 483.

[2] Variations in the composition and feeding value of purchased feeding stuffs, p. 7.

AVERAGE COMPOSITION.

	Punjab.	Central Provinces.	Bombay Presidency.	Madras Presidency.
Moisture	7·60	6·73	6·81	6·72
Oil	38·27	41·36	40·71	40·12
Albuminoids	14·86	18·50	19·74	19·07
Soluble Carbohydrates	29·17	24·62	24·23	24·94
Woody fibre	5·74	4·80	5·01	5·35
Soluble mineral matter	3·72	3·22	2·96	3·26
Sand	·64	·77	·54	·54
	100·00	100·00	100·00	100·00
Total Nitrogen	2·55	3·05	3·28	3·14
Albuminoid Nitrogen	2·38	2· 97	3·12	3·05

PAPAVER SOMNIFERUM—(*Poppy seed*).

The same remark must be made in relation to this seed as applied to Bassia latifolia. The number of specimens is so small as to preclude any general conclusions regarding the amount of oil in this seed in different parts of India. The variations in the specimens examined were, however, very small.

Sample No.	District.	Oil. Per cent.	Weight of 100 seeds. Grms.
	United Provinces.		
670—04	Cawnpore	47·90	·031
671—04	Do.	47·58	·034
930—04	Do.	47·60	·037
976—04	Unao	47·32	·036
977—04	Do.	46·35	·035
978—04	Partabgarh	48·33	·033
979—04	Do.	48·66	·033
980—04	Cawnpore	48·20	·038
	Bengal.		
496—04	. ...	48·13	·034
	Burma.		
573—04	....	44·82	·035

RICINUS COMMUNIS—(*Castor Bean*).

Numerous specimens of this seed have been examined. The list includes thirty-nine from Madras, thirteen from Bombay, twenty from the United Provinces and twenty-five from the Central Provinces. The oil was determined in the kernel ; the percentage in the whole seed was calculated from this figure after

allowing for the shell. With very few exceptions, the oil varies in kernels from 60 to 70 per cent., and this variation may be considered small. As is well known, the size of this seed varies very much indeed, and this is shown by the last column of the statement. The weight per 100 seeds is as low as 9 grms. in one case, and as high as 59·7 in another—a difference far greater than occurs in other oil-seeds, and is indeed quite remarkable. The percentage of shell is, however, much more constant. Moreover, a high proportion of shell is not coincident with a small seed, and presumably the thickness of the shell increases slightly with the size of the seed.

Sample No.	Vernacular Name.	District.	Kernels. Per cent.	Shells. Per cent.	Oil in kernels. Per cent.	Oil in whole seed. Per cent.	Weight of 100 seeds. Grms.
		Madras Presidency.					
140—03	Large seed ...	Vizianagram ...	74·24	25·76	66·88	...	...
150—03	Small do. ...	Godavery ..	69·23	30·77	67·00	...	...
1230—04	Castor seed ...	Do. ..	69·95	30·05	67·07	46·91	22·3
1231—04	Do. ...	Do. ...	71·42	28·58	67·05	47·88	21·8
1317—04	Do. ...	Do. ...	70·79	29·21	67·12	47·51	22·6
424—04	Do. ...	Kistna ...	70·61	29·39	67·81	47·88	21·1
663—04	Do. ...	Do. ..	69·80	30·20	67·01	46·77	19·8
569—04	Do. ..	Karnool .	69·62	30·38	68·96	48·00	31·6
816—04	Do. ..	Do. ...	66·66	33·34	67·95	45·29	20·4
817—04	Do. ...	Do. ...	69·43	30·57	70·69	49·08	22·9
1049—04	Chitamidalu ...	Bellary ...	68·01	31·99	69·19	47·05	17·7
1050—04	Paddamidalu ..	Do. ...	67·34	32·66	67·78	45·64	19·6
1054—04	Do. ..	Do. ..	67·19	32·81	67·59	45·41	18·9
1088—04	Castor seed, small	Do. ...	68·58	31·42	65·19	44·70	21·2
410—04	Castor seed ...	Anantpur ...	69·25	30·75	69·62	48·21	29·6
501—04	Do. ...	Do. ...	67·51	32·49	67·84	45·79	23·7
539—04	Do. big ...	Cuddappah ...	71·33	28·67	63·97	45·62	23·2
540—04	Do. small ...	Do. ...	61·66	38·34	57·46	35·42	9·0
449—04	Castor seed ...	Nellore ...	69·23	30·77	60·31	41·75	14·6
450—04	Do. ...	Do. ...	70·49	29·51	68·53	48·30	16·1
316—04	Do. ...	Salem ...	66·12	33·88	63·42	41·93	21·5
345—04	Do. ...	Do.	64·67	35·33	67·19	43·45	26·7
446—04	Do. ...	Do. ...	68·00	32·00	71·12	48·36	30·0
447—04	Do. ...	Do. ...	68·57	31·43	61·69	42·30	14·0
566—04	Do. ...	Do. ...	72·41	27·59	70·10	50·75	34·8
632—04	Do. ...	Do. ...	70·77	29·23	67·61	47·84	33·1
1035—04	Do. ...	Do. ...	68·81	31·19	69·67	47·93	31·1
1060—04	Do. ...	Do. ...	70·43	29·57	65·79	46·33	27·4
1061—04	Do. ..	Do. ...	69·92	30·08	67·43	47·14	33·2
1202—04	Do. large ...	Do. ...	70·68	29·32	64·62	45·67	30·7
1203—04	Do. small ...	Do. ...	66·39	33·61	67·20	44·61	18·1
1229—04	Do. ...	Do. ...	70·99	29·01	70·93	50·35	36·2
1417—04	Castor seed, big ...	Coimbatore ...	70·90	29·10	67·51	47·86	27·5
1418—04	Castor seed, small	Do. ..	65·75	34·25	63·16	41·52	14·6
1055—04	Sithamanakku ...	Madura ...	68·95	31·05	64·10	44·19	21·9
1056—04	Do. ..	Do. ...	67·77	32·23	62·51	42·36	18·0
1057—04	Periamanakku ...	Do. ...	62·34	37·66	56·22	35·04	39·3
1058—04	Do. ...	Do. ...	70·34	29·66	59·76	42·03	29·0
1059—04	Katamanakku ...	Do. ...	66·42	33·58	70·65	46·92	27·1

Sample No.	Vernacular Name.	District.	Kernel. Per cent.	Shells. Per cent.	Oil in Kernels. Per cent.	Oil in wholeseed. Per cent.	Weight of 100 seeds. Grms.
		Bombay Presidency.					
187—04	Castor seed ...	Ahmedabad ...	71·84	28·16	58·85	42·27	25·7
402—04	Do.	Kaira ...	72·30	27·70	64·50	46·63	37·2
459—04	Diveli ...	Surat ...	73·15	26·85	64·77	47·37	22·6
243—04	Castor seed ...	Nasik ...	73·24	26·76	55·24	40·45	40·8
249—04	Do. ...	Poona ...	74·08	25·92	64·41	47·71	41·9
460—04	Diveli ...	Do. ...	75·98	24·02	63·75	48·43	45·8
256—04	Castor seed	Sholapur ...	68·17	31·83	63·22	43·09	19·8
268—04	Do.	Dharwar ...	65·10	34·90	65·69	42·76	16·0
326—04	Do. ...	Satara ...	73·05	26·95	61·30	44·77	37·3
475—04	Do. ...	Bijapur ...	72·43	27·57	65·43	47·39	37·0
1175—04	Do. ...	Belgaum ...	70·82	29·18	71·95	50·95	42·8
1179—04	Do. ...	Do. ...	74·36	25·64	63·87	47·49	31·2
1183—04	Do. ...	Do. ...	69·05	30·95	65·41	45·16	23·2
		United Provinces.					
676—04	Castor seed, large ...	Sultanpur ...	71·35	28·65	68·46	48·84	55·3
677—04	Castor seed, large ...	Do. ...	69·97	30·03	66·46	46·52	58·9
678—04	Castor seed, small ...	Do. ...	69·05	30·95	64·45	44·50	19·4
679—04	Castor seed, small ...	Do. ...	70·62	29·38	64·28	45·39	21·5
931—04	Randi, large ...	Cawnpore ...	70·33	29·67	65·66	46·17	36·4
932—04	Do. small ...	Do. ...	67·98	32·02	65·77	44·77	20·1
981—04	Do. large ...	Do. ...	73·01	26·99	61·89	45·18	34·4
988—04	Do. small ...	Do. ...	71·42	28·58	64·13	45·80	20·3
982—04	Do. large ...	Partabgarh ...	60·49	39·51	64·20	38·83	40·8
983—04	Do. ...	Do. ...	46·95	35·05	64·12	41·64	38·8
989—04	Do. ...	Do. ...	67·50	32·50	66·27	44·73	20·0
990—04	Do. ...	Do. ...	68·50	31·50	65·56	44·90	20·0
984—04	Do. ...	Aligarh ...	73·71	26·29	62·92	46·37	45·6
985—04	Do. ...	Do. ...	72·48	27·52	64·38	46·66	47·8
991—04	Do. ...	Do. ...	68·65	31·35	62·71	43·05	20·1
992—04	Do. ...	Do. ...	67·96	32·04	63·33	43·03	20·6
986—04	Do. ...	Unao ...	71·71	28·29	66·43	47·63	46·6
987—04	Do. large ...	Do. ...	72·09	27·91	67·60	48·73	50·6
993—04	Do. ...	Do. ...	67·06	32·94	65·62	44·00	16·7
994—04	Do. ...	Do. ...	68·02	31·98	65·97	44·87	17·2
		Central Provinces.					
107—04	Undi ...	Jabalpur ...	73·60	26·40	60·69	44·66	59·7
117—04	Do.	Hoshangabad ...	70·60	29·40	60·72	42·85	43·5
544—04	Badi Andi ...	Do. ...	72·33	27·67	63·46	45·90	55·3
119—04	Castor ...	Nimar ...	70·14	29·86	61·42	43·07	69·0
134—04	Do., large ...	Damoh ...	72·72	27·28	62·93	45·76	46·7
135—04	Do., small ...	Do. ...	69·56	30·44	60·70	42·22	14·2
161—04	Andi ...	Raipur ...	59·14	40·86	62·03	36·68	12·9
169—04	Jada ...	Sambalpur ...	70·02	29·98	65·09	45·57	19·5
177—04	Castor ...	Do. ...	68·50	31·50	65·58	44.93	18·0
195—04	Kachhari ...	Balaghat ...	69·72	30·28	64·95	45·28	32·0
196—04	Wevri ...	Do. ...	73·11	26·89	67·98	49·70	42·6
208—04	Castor ...	Narsingpur ...	71·20	28·80	61·16	43·54	25·3
226—04	Do. ...	Chanda ...	69·00	31·00	62·00	42·78	27·5
227—04	Do. ...	Do. ...	68·44	31·56	64·49	44.13	23·1
228—04	Do. ...	Do. ...	63·38	36·62	64·09	40·62	23·9
229—04	Do. ...	Do. ...	69·03	30·97	61·35	42·34	26·0
545—04	Yerandi ...	Wardha ...	66·14	33·86	58·39	38·61	12·8
550—04	Do. ...	Do. ...	74·93	25·07	63·80	47·80	50·3
576—04	Andi Badi ...	Chhindwara ...	67·30	32·70	69·46	46·74	41·6
577—04	Do. Chhoti ...	Do. ...	71·23	28·77	64·21	45·73	23·8
706—04	Yendi ...	Betul ...	70·92	29·08	64·36	45·64	24·3
915—04	Castor, large ...	Bilaspur ...	73·61	26·39	64·82	47·71	53·5
916—04	Do., small ...	Do. ...	64·03	35·97	64·63	41·38	15·8
1223—04	Andi Badi ...	Nagpur ...	72·91	27·09	63·07	45·98	49·0
1224—04	Do. Chhoti ...	Do. ...	71·21	28·79	65·83	46·87	27·1

AVERAGE COMPOSITION.

	Madras.	Bombay.	Central Provinces.	United Provinces.
Moisture	4·85	4·11	3·98	4·17
Oil	63·62	56·71	63·72	63·22
Albuminoids	18·15	20·75	20·88	19·36
Soluble Carbohydrates	8·88	14·46	7·52	8·98
Woody fibre	1·53	·95	1·03	1·02
Soluble mineral matter	2·92	2·87	2·72	3·01
Sand	·05	·15	·15	·15
	100·00	100·00	100·00	100·00
Total Nitrogen	3·06	3·41	3·56	3·22
Albuminoid Nitrogen	2·90	3·32	3·34	3·10

Average proportion of shells and kernels :—

	Madras.	Bombay.	Central Provinces.	United Provinces.
Kernels, per cent.	68·79	71·81	69·88	69·34
Shells, per cent.	31·21	28·19	30·12	30·66

Composition of whole seed, calculated on the assumption that the shells are entirely indigestible "woody fibre" :—

	Madras.	Bombay.	Central Provinces.	United Provinces.
Moisture	3·34	2·95	2·78	2·89
Oil	43·75	40·70	44·51	43·93
Albuminoids	12·50	14·96	14·60	13·40
Soluble Carbohydrates	6·10	10·35	5·26	6·23
Woody fibre	32·26	28·87	30·84	31·37
Soluble mineral matter	2·01	2·06	1·90	2·08
Sand	·04	·11	·11	·10
	100·00	100·00	100·00	100·00
Total Nitrogen	2·10	2·44	2·48	2·23
Albuminoid Nitrogen	1·99	2·38	2·33	2·15

SESAMUM INDICUM—(*Vern. Til, Jinjelly.*)

	Area in British India. Acres.	Yield. Tons.
Grown as single crop	4,000,000	[1]300,000
Grown in mixed crop	500,000	

The specimens of this oil seed varied considerably in size and in colour, as well as in the amount of oil. The shape of the different seeds remains constant, but some are nearly twice as heavy as others ; the weight of 100 seeds varied from about ·18 to ·35 grammes in extreme cases and, excluding such exceptions, the

[1] This yield suffer s great fluctuations from year to year.

variation may be said to be from ·22 to ·33 grammes. The *colour* is commonly either white, black, or brown, though some of the Central Provinces seed is more of a brick-red. Different specimens, however, vary much in colour between the limits named.

Most of the specimens were fairly free from admixture of earth, and they were quite free from seeds of other plants. On the other hand, no sample could be called pure, for there was invariably a greater or less quantity of varieties other than the predominating one ; in some cases the mixtures could not be designated by any colour in particular.

Regarding the percentage of oil, the variation is from about 48 to 52, though some specimens contained as much as 58 per cent., and some as little as 45 per cent. These variations appear to be independent of variety, Province or climate.

The specimens are arranged in the accompanying statement according to the colour of the seed as far as possible :—

Sample No.	District.	Province.	Oil. Per cent.	Weight of 100 seeds. Grms.
		White.		
13—04	Gurgaon	Punjab	46·49	·323
82—04	Kangra	Do.	53·06	·286
93—04	Umballa	Do.	51·12	·335
151—04	Rawalpindi	Do.	51·98	·280
75—04	Seoni	Central Provinces	49·38	·189
100—04	Jabalpur	Do.	47·31	·197
114—04	Hoshangabad	Do.	47·22	·250
121—04	Nimar	Do.	51·82	·282
129—04	Damoh	Do.	45·15	·224
173—04	Sambalpur	Do.	51·17	·233
198—04	Balaghat	Do.	52·43	·235
204—04	Narsingpur	Do.	48·64	·251
211—04	Chanda	Do.	52·45	·228
213—04	Do.	Do.	50·73	·231
290—04	Mandla	Do.	50·89	·215
186—04	Ahmedabad	Bombay Presidency	51·14	·319
247—04	Poona	Do.	51·22	·297
257—04	Sholapur	Do.	57·79	·286
253—04	Ahmednagar	Do.	55·27	·304
265—04	Kanara	Do.	55·57	·256
266—04	Dharwar	Do.	56·07	·339
		Black.		
18—04	Chenab Canal	Punjab	48·27	·357
87—04	Muzaffergarh	Do.	48·51	·378
67—04	Montgomery	Do.	46·41	·291
136—04	Sialkot	Do.	47·15	·313
101—04	Jabalpur	Central Provinces	47·37	·228
102—04	Do.	Do.	45·45	·232
199—04	Balaghat	Do.	50·44	·242
112—04	Hoshangabad	Do.	49·90	·274
205—04	Narsingpur	Do.	47·47	·263

Sample No.	District.	Province.	Oil. Per cent.	Weight of 100 seeds. Grms.
		Black—(concld.)		
130—04	Damoh	Central Provinces	45·45	·257
291—04	Mandla	Do.	47·56	·210
157—04	Raipur	Do.	49·07	·249
168—04	Sambalpur ...	Do.	50·77	·264
242—04	Nasik	Bombay Presidency ...	51·19	·337
264—04	Kanara	Do.	55·94	·318
269—04	Dharwar	Do.	54·50	·356
		Brown.		
8—04	Hissar	Punjab	48·71	·333
94—04	Umballa	Do.	47·92	·374
142—04	Gujrat	Do.	48·27	·320
289—04	Mandla	Central Provinces	47·61	·220
		Red.		
113—04	Hoshangabad ...	Central Provinces	53·01	·319
175—04	Sambalpur... ..	Do.	53·97	·347
214—04	Chanda	Do.	52·70	·315
215—04	Do.	Do.	51·86	·296
216—04	Do.	Do.	51·51	·326
218—04	Do.	Do.	50·94	·305
185—04	Ahmedabad ...	Bombay Presidency ...	52·79	·348
		White, Brown and Black mixed.		
120—04	Nimar	Central Provinces	53·52	·335
174—04	Sambalpur ...	Do.	51·54	·253
212—04	Chanda	Do.	49·98	·291
217—04	Do.	Do.	53·25	·242

The following illustrates the average composition of the seed :—

	White.	Black.	Brown.	Red.
Moisture	5·11	4·78	4·61	4·76
Oil	49·90	48·57	47·60	50·16
Albuminoids	16·25	18·93	18·73	18·50
Soluble Carbohydrates	17·79	15·88	16·41	15·69
Woody fibre	4·26	4·03	4·05	4·17
Soluble mineral matter	6·00	6·75	6·87	5·76
Sand	·69	1·06	1·73	·96
	100·00	100·00	100·00	100·00
Total Nitrogen	3·06	3·13	3·09	3·06
Albuminoid Nitrogen	2·59	3·03	3·01	2·96

THE EFFECT OF TRANSFERRING OIL-SEEDS TO ANOTHER PROVINCE.

It is known that the quality of a plant may be changed in one or another respect by transference to a different soil or climate. Thus it has been found that sugarcane may produce a poorer juice after such a change, though this is not universally the case.

After the oil-seeds had been tested, and it was known that some samples contained appreciably more oil than others of the same botanical order, specimens of the richer were in several cases grown at farms where seed of poorer quality was generally produced. Excepting in one case, the imported seed was not examined and only the newly-grown seed submitted to analysis. Although, in some cases, the latter was not so rich in oil as was the sample that had been originally tested in this laboratory, there was, strictly speaking, nothing to compare the newly-grown crop with. This precaution was, however, taken in the case of some linseed which was brought from different places to Lyallpur in the Punjab, and in the subjoined statement the percentage of oil in the original seed and in the crop is set out :—

	Original seed.	Produce of 1905.	Produce of 1906.
Linseed White from Cawnpore	44·62	41·28	39·90
Do. do. do. Khandwa	44·96	44·18	42·93
Do. do. do. Damoh	45·34	43·07	43·57
Do. Brown do. Partabgarh	43·17	40·98	38·31
Do. do. do. Cawnpore	42·05	40·97	39·43
Do. do. do. Sholapur	41·13	40·42	38·82

There has thus been a decline throughout. It remains to be seen whether this decline ceases, and whether after acclimatization the seed will regain its former richness or not.

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